THE EXPLOSIVES ENGINEER

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Forerunner of Progress in Mining, Quarrying, Construction

CONTENTS

GEORGE KERR MACKIE, JR.—*a biography* 4

GEORGE KERR MACKIE, JR.—*a photograph* 5

Editorial 6

Crossing a Wide, Deep River With Two Pipe Lines 7
By J. E. McCLINTON

Miners and Quarrymen Honored at Safety Award Ceremonies 13

Blasting a Channel Through New Jersey Mud Flats 18
By PAUL W. MILLER

Striking Off the Boss 20
By J. J. RUTLEDGE

San Francisco's Broadway Tunnel Under Russian Hill 22
By ROBERT LEE BEHME

Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

Crossing streams with pipe lines is not an unusual assignment for contractors who specialize in that type of construction work. Ditches are excavated in the beds of streams at crossing locations, and sections of welded pipe are laid in man-made ditches. When rock is encountered, drilling and blasting have to be done in stream beds under water.

An example of completing a rock job of this kind under difficult working conditions is the recent crossing of the 4,000-ft.-wide Tennessee River at Pride, Alabama, with two parallel pipe lines 50 ft. apart, by Oklahoma Contracting Company. The depth of the water in the 1,400-ft.-wide channel averaged 31.53 ft. The bottom of the channel area was hard lime rock, requiring the blasting of 1,089 well-drill holes to make ditches 8 ft. deep.

A description of the methods and equipment used by the contractor in completing this project is presented by J. E. McClinton in the article beginning on page 7.

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The employes of four mines and one quarry, winners in their respective classifications in the National Safety Competition of 1951, were honored by company officials and friends at appropriate ceremonies. On each occasion, the program of events was highlighted by the presentation of Sentinels of Safety trophies and flags, and individual Certificates of Achievement in Safety. A summary of the proceedings at the ceremonies, sponsored by the winning companies, is given in "Miners and Quarrymen Honored at Safety Award Ceremonies," beginning on page 13.

° ° °

In building a new four-lane boulevard in New Jersey last fall, George M. Brewster & Son, the contractor, had to place 600,000 cu. yds. of fill alongside the right-of-way. This operation closed the end of a creek and a new channel had to be opened through mucky silt. Blasting with dynamite was introduced successfully and the new channel was opened speedily and economically. The details of how the muck was blasted may be found on page 18.

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Our readers will recall a series of articles by Dr. John J. Rutledge published in THE EXPLOSIVES ENGINEER during the past 23 years. A short time before his death in August, 1952, Dr. Rutledge sent to us his last article in the series, entitled "Striking Off the Boss." Please turn to page 20.

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San Francisco's famous hills became a problem to the City Fathers as early as 1863, when the need for shorter routes to rural districts became apparent. In time, tunnels arrived on the San Francisco landscape. The most recent is the Broadway Tunnel under Russian Hill.

As construction work progressed, the predicted hard-rock conditions were not encountered and the plans of the contractor, Morrison-Knudsen Company, had to be changed. A new technique was developed with the introduction of a unique breastboard jumbo, which made possible full-bore operations and a tunnel advance of 15 ft. a day through badly fractured ground.

Some of the problems that had to be solved and how they were overcome successfully will be found in the article by Robert Lee Behme, beginning on page 22.

EDITORIAL STAFF: JOSEPH I. HORTY, *Managing Editor;* ELIZABETH M. JOYCE, *Assistant Editor;* GERTRUDE A. DONNELLY, *Assistant Editor;* EDWARD L. GRANT, *Art Editor;* FRANK J. CANOVA, *Production Manager;* CHARLES E. RABENOLD, *Advertising Manager;* THEODORE MARVIN, *Director;* MONTGOMERY R. BUDD, *Associate Director.*

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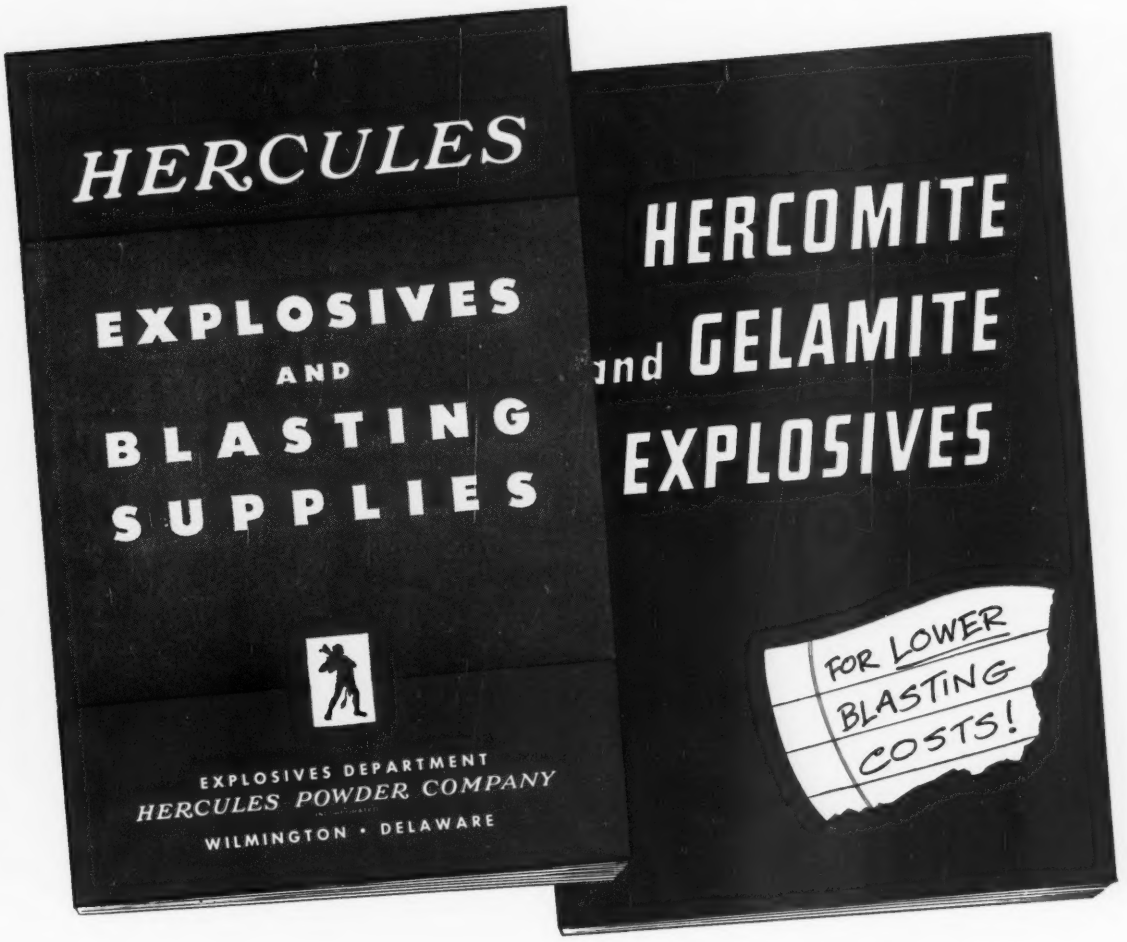

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George Kerr Mackie, Jr.

PRESIDENT

THE CLEMENS COAL COMPANY

A Biography

THE complex pattern of American industry today calls for leaders who are qualified, through ability, training, and experience, to direct operations and, at the same time, to be conscious of a responsibility to employers, employes, and the public. George Kerr Mackie, Jr., president of The Clemens Coal Company, Pittsburg, Kansas, measures up to these exacting requirements in every particular. The progressive development of the company's strip-mining activities in the southeast Kansas bituminous-coal field in recent years is attributable to Mr. Mackie's sound judgment, keen business acumen, and close cooperation with his associates in all phases of company business.

George, as he is known to his friends and associates, was born August 30, 1904, in Scammon, Cherokee County, Kansas, the son of George Kerr and Flora Elizabeth (Bush) Mackie.

His father had come to this country from Scotland in 1876, settling in Diamond, Illinois, where he worked in local mines for five years. In 1881, he moved to Scammon, Kansas, to accept employment with Keith and Perry Coal Company. In 1905, he organized his own company under the name of George K. Mackie Fuel Company, with headquarters in Scammon. Ten years later the Mackie family moved to Lawrence, Kansas, primarily for the purpose of having the children attend the local schools and avail themselves of the benefits to be derived from excellent facilities. He continued to maintain his coal company headquarters in Scammon, and operations were carried on in that area.

When George, Jr., was fifteen, during the summer vacation months, he made his first contact with industry, as a capping machine operator in a canning factory in Lawrence. He continued this schedule of summer work during his high school days, accepting employment in a wide variety of jobs ranging from farm hand to laborer with a construction crew.

After George had completed his elementary education in the public schools in Lawrence, he went to the University of Kansas and was graduated in 1928, with an A.B. degree. During his undergraduate days at the university he was a prominent member of the varsity football team, and was elected to membership in Phi Gamma Delta fraternity.

Following his graduation from the University of Kansas, George became a salesman for Mackie Clemens Coal Company of Pittsburg, Kansas. After two years of selling experience on the road, he moved into the operations end of the coal business as tipple foreman for Commercial Fuel Company, in Pittsburg. In the latter part of 1930, he began his long and eventful association with The Clemens Coal Company and, one year later, was made general manager. Shortly after receiving this promotion, he was elected to the vice presidency, and in 1947, was made company president.

In addition to directing the activities of The Clemens Coal Company, Mr. Mackie is president of Buildex, Incorporated of Ottawa, Kansas; vice president of The Mackie Clemens Fuel Company of Kansas City, Missouri; a director of The First State Bank of Pittsburg, Kansas; and a member of both the Kansas Industrial Development Commission and the Mineral Industries Council. He is a member of the First Presbyterian Church in Pittsburg.

His club affiliations include the Missouri Athletic in St. Louis, the Kansas City in Kansas City, Missouri, and the Elks in Pittsburg, Kansas.

George Kerr Mackie, Jr., married Maxine Williams on June 15, 1936, in Broken Arrow, Oklahoma. They have two daughters: Mollie, age eleven, and Merrie, age five. The family home is at 310 Winwood Street in Pittsburg, Kansas.

Although he typifies the axiom "business before pleasure," George Mackie maintains a keen interest in sports of all kinds. In recent years, because of the demands of his business affiliations, he limits his activities to fishing expeditions with his family and friends in the lakes and streams that abound in his native state and in the adjoining areas.

GEORGE KERR MACKIE, JR.

Editorial

Explosives Research

Hidden in the background of the industrial expansion of the United States is dynamite, one of the most useful tools that man has yet devised for overcoming the obstacles of nature. Until the advent of dynamite in 1867, conditions in this country were almost as crude as when Columbus landed in 1492. With the introduction of dynamite and its application for industrial uses, the building of railroads over and through mountains, the mining of minerals on a huge scale, and the constructing of great irrigation and power projects and wide, level highways were made possible.

Today, chemists have devised a series of explosives to meet economically, efficiently, and safely the particular demands of industry. Regardless of the type of coal, ore, or rock encountered, and the conditions under which they must be blasted, there are explosives available today exactly suited to obtain the desired results.

Explosives manufacturing companies are continually on the alert for means of improving their products. Research staffs are maintained for the utilization of every instrument and method of modern science to perfect their understanding of this highly specialized field. Each approach to it, whether from the direction of theoretical physics and chemistry, or from actual tests in the field, is thoroughly explored. Such intensive investigation is directed not only to dynamite, but also to detonators, blasting machines, safety fuse, and other blasting accessories.

Short-Period Delay Electric Blasting Caps

An example of the results of such research efforts was the development, a few years ago, of short-period delay electric blasting caps. They were introduced originally for use where vibrations from blasting were a problem. It was soon discovered that in addition to minimizing vibrations, they also improved fragmentation and practically eliminated endbreak and backbreak. As a result, they have been adopted enthusiastically by many operators of quarries, open-pit mines, underground mines, and coal strippings, and by contractors on heavy-construction projects.

Whether or not explosives research has been economically sound can be left to the decisions of users who remember the explosives available 20 or 25 years ago. Even the older types of dynamite have been improved in texture, sensitiveness, fumes, water resistance, and other important characteristics. Formulas and manufacturing methods have benefited from the findings of research workers. Explosives makers are justly proud of these accomplishments.

Customers of the industry may rest assured that the resources devoted to the improvement of dynamite and blasting supplies will continue to be maintained and expanded.

Permissible Explosives

The U. S. Department of the Interior, Bureau of Mines, made public recently a revised list of explosives which have been declared "permissible" for use in coal mines, under the safety standards of the Bureau. It supersedes all previous lists. The brands no longer being manufactured have been transferred to the inactive list, and those which have been admitted to the active list are shown in the report. Class designation according to the weight of 1¼ by 8-in. cartridges, the velocity of detonation, the volume of poisonous gases, and the manufacturer of each brand are also included in the revised list.

One of the important permissibility tests made at the Bureau's testing stations involves the firing of charges of explosives from a cannon into a gallery filled with an explosive mixture of air and natural gas, or air, natural gas, and coal dust. If the firing of an explosives charge ignites one of these mixtures, it fails the test.

A copy of the report, referred to as Information Circular 7640, may be obtained without charge from Publications-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pennsylvania.

Check Your Leading Wire

We have commented before in these columns that a complaint is seldom registered against electric blasting caps of reliable manufacturers. When such a complaint is made, investigation usually discloses that the electric blasting caps were made correctly but that improper execution was caused by a faulty electrical hookup, resulting in insufficient current reaching the caps.

When the electrical hookup is examined, it is found that the most frequent cause of misfires is the leading wire; it is either poorly insulated or is incorrectly strung. If the wire has passed usefulness, nothing can be done about it except to purchase new leading wire. If the wire was used improperly, the remedy is to string it with such care that it will not lose more current than the ordinary transmission losses.

Good leading wire is essential to successful blasting. Every operator should make certain that his leading wire is of good quality and that it is used correctly.

Crossing a Wide, Deep River With Two Pipe Lines

A summary of construction details involved in laying 30-in. and 24-in. pipe lines in rock ditches under 40 ft. of water across the 4,000-ft.-wide Tennessee River

J. E. McCLINTON*

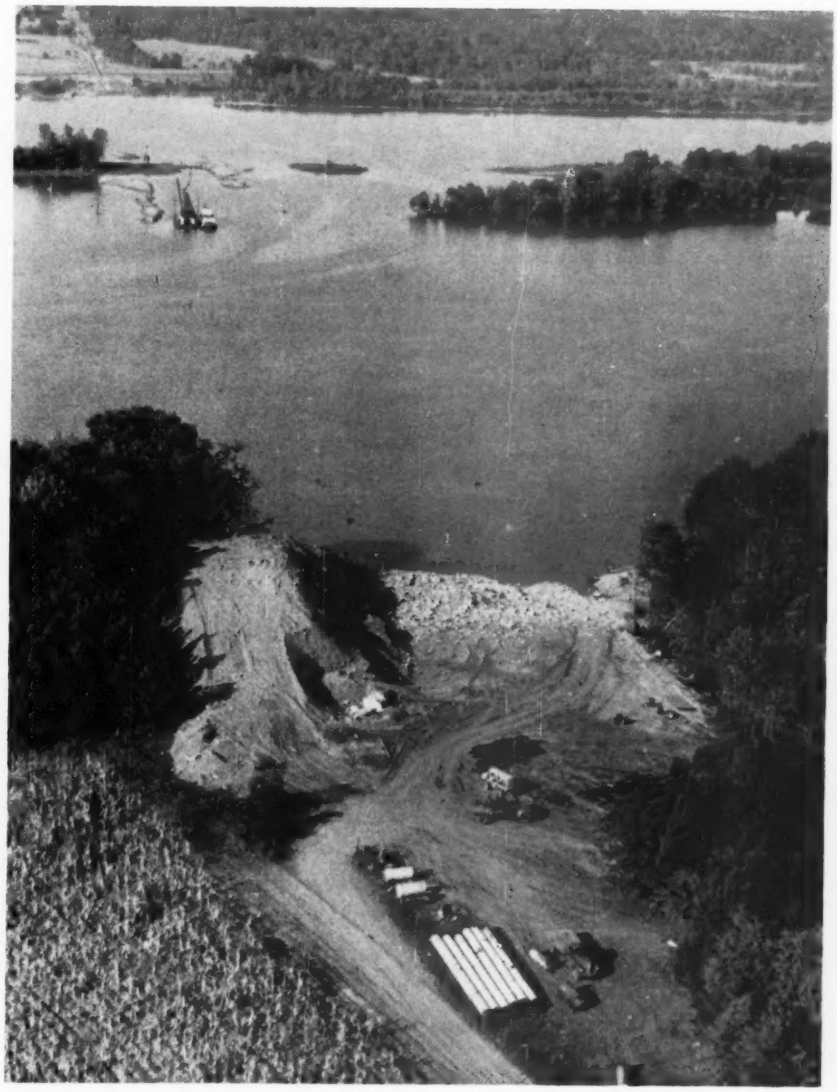
THE crossing of rivers and lakes with pipe lines is not an unusual job requirement for contractors who specialize in that type of construction work. Trenches are excavated in the beds of streams at the crossing locations, after which sections of welded pipe are laid in the man-made trenches. When rock is encountered, drilling and blasting have to be done. In many such cases, the details involved in the drilling of holes in the rock, the loading of explosives charges, and the firing of blasts under deep water in wide streams call for skills and ingenuity of a high order.

An example of completing a rock job of this kind under difficult working conditions is the recently completed crossing of the Tennessee River at Pride, Alabama, with two parallel pipe lines 50 ft. apart—a 30-in. main line and a 24-in. standby line. All work on the river crossing was done by Oklahoma Contracting Company of Dallas, Texas, operating under a subcontract with Brown & Root, Inc., of Houston, Texas. The latter organization was the prime contractor on a major pine-line project for Texas Eastern Transmission Company of Shreveport, Louisiana, for the purpose of transporting natural gas from Kosciusko, Mississippi, to Connellsville, Pennsylvania.

The Tennessee River At Pride, Alabama

At the crossing location, the width of the river is 4,000 ft., with the main channel 1,400 ft. wide. The

*Hercules Powder Company
Birmingham 5, Alabama



THE WIDE, DEEP RIVER: At the crossing location, the Tennessee River is 4,000 ft. wide, with a main channel 1,400 ft. wide. The water depth in the channel averages 31.53 ft., covering a formation of hard lime rock.

DRILLING IN THE CHANNEL: Holes for blasting the rock in the channel bottom were drilled by the operation of six well-drill machines on the barge in the background, anchored between the two ditch lines. The barge in the foreground is an all-purpose work-and-supply unit.

THE DRILL BARGE: A close-up of the drill barge made by placing two 25 by 100-ft. barges side by side and spot welding them together. The spud bars in the center were added to hold the barge on the ditch line.

TYING THE PRIMACORD: The branch lines of Primacord, extending from each of the holes loaded with dynamite, were tied to the main line of Primacord strung along the center of each ditch line. Later, the two trunk lines were connected with Primacord at intervals of 50 to 75 ft.

FINAL CONNECTIONS: After completing the tie-ins, the blasting crew strung No. 20 copper wire and made connections with the leg wires of the electric blasting caps taped onto the end of each Primacord trunk line.

BLASTING ROCK UNDER DEEP WATER: The first blast in the Tennessee River channel involved the simultaneous detonation of 31,350 lbs. of Gelamite-D loaded into well-drill holes in hard lime rock covered with approximately 40 ft. of water. The results obtained conformed with the contract specifications in every detail.

maximum depth of the water in the channel is 40 ft.; the average is 31.53 ft. The bottom of the channel area was hard lime rock, which extended beyond the south bank of the river for a distance of 150 ft. This latter condition necessitated considerable drilling, blasting, and excavating before equipment could be moved onto barges for work in the river.

On the north side of the channel, in an area 2,600 ft. wide, the depth of the water varied from 3 to 8 ft.—backwater from nearby Pickwick Dam. Soundings taken in this area indicated that the material in the stream bed was a muck formation. Subsequent operations developed that it was a hard red clay, stratified with thin layers of sand. It had to be blasted before any dredging progress could be made. The results from the employment of a 10-in. suction dredge in this material were not satisfactory. The introduction of a dragline with a clamshell bucket proved to be the answer to the immediate problem.

The required depth of the two ditches for the pipe lines was approximately 8 ft., with a bottom width averaging 6 ft. This depth of ditch allowed for a minimum cover of 3 ft. of backfill over the pipe in place. Permission to blast the rock in the river channel bed was obtained from the U. S. Army Corps of Engineers. Because the river is navigable, blasts in the main channel had to be made in four separate sections to avoid any possible interference with river traffic.

Drilling Holes in Hard Rock In the River Bed

Drilling operations were contracted for by H. W. Peerson Drilling Company of Birmingham, Alabama, under the supervision of R. L. (Buck) Peerson. To drill holes in the hard rock formation at the bottom of the main channel, a barge had to be made available. This was done by placing two 25 by 100-ft. barges side by side and spot welding them together. Spud bars were utilized to hold the barge on the ditch line. Six well-drill machines were placed on the barge, five Model 50 Keystones and one 22W Bucyrus-Erie. The drill bits for these machines were 2¼ by 3¼ 7API-6 in., with stems 4½ in. by 18 ft. The total

SUBMARINE BLASTING IN RED CLAY: Before satisfactory dredging progress could be made in the river on the north side of the channel, a hard red clay formation on the bottom had to be blasted. The picture above shows 12,000 lbs. of Gelamite-D in action in the clay with 3 to 8 ft. of water covering.

weight of the stems and bits was 1,800 lbs. Three of the drills were stationed on opposite sides of the barge to permit the drilling of two lines of holes at the same time for each ditch line. One line of holes was drilled close to the barge and a second line of holes was drilled 5 ft. out from and staggered between the first line. This was accomplished by jacking up the drill machines and tilting the booms outward until they reached the required distance of 5 ft. between the two lines of holes. After a hole was drilled, it was lined with a 6-in. steel casing which extended 3 ft. above the surface of the river water. The casings were connected with angle iron, crosswise and lengthwise.

A total of 1,089 holes was drilled into the rock under water in the main channel. The depth of holes ranged from 12 to 28 ft., averaging 14.25 ft. per hole. An approximate total of 40,000 ft. of 6-in. steel casing was used to line the holes.

Before explosives charges could be loaded into the drill holes they had to be cleaned out. Three methods were tried: a 300-lb. pressure jet pump; a suction pump; and compressed air from a 500-c.f.m. Ingersoll-Rand compressor. The compressed-air method produced the most satisfactory results and was adopted. After the holes were cleaned, charges of Gelamite-D dynamite packed into 5 in. by 25-lb. 23G containers with tape ties were loaded into them. The loading ratio for the explosives was 16.5 lbs. of dynamite per cu. yd. of rock in the solid. The charge in each hole was primed with reinforced Primacord.

After the holes were loaded, a trunk line of Primacord was strung along the center of each ditch line. The branch lines of Primacord extending from each of the loaded holes were tied to the trunk line. When this was completed, the two trunk lines were connected with Primacord at intervals of 50 to 75 ft. A Hercules* Electric Blasting Cap was taped onto the end of each trunk line and the leg wires of the caps were connected to a No. 12 copper lead wire. When the "all clear" signal was given, the lead wire was connected to a Hercules 50-Cap Blasting Machine and the blast was fired.

As indicated previously, blasting in the main channel had to be done in four individual sections. Each blast

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CHIEF INSPECTOR: Charles Boatman was chief river-crossing inspector for the prime contractor, Brown & Root, Inc., Houston.

DIRECTOR OF OPERATIONS: Paul R. Halbert, Oklahoma Contracting Company, directed operations for his company.

ENGINEER: Harry A. B. Prindle, engineer on the river-crossing project for Oklahoma Contracting Company.

included the firing of the loaded holes in the two ditches simultaneously. In the first section blasted, 31,350 lbs. of dynamite were used; in the second, 75,000 lbs.; in the third, 54,650 lbs.; and in the fourth, 83,000 lbs. The dynamite fired in the four sections in the main channel totaled 244,000 lbs.

Gelamite-D* and Primacord Simplified Loading Operations

Gelamite-D dynamite in 23G containers with tape ties, primed with reinforced Primacord, proved to be an ideal combination on this job. Not only did they make possible excellent blasting results but they simplified and speeded up the mechanics of loading the explosives charges. This was of particular importance since all the holes had to be loaded from barges and a boardwalk between the rows of holes in each ditch line.

*Reg. U. S. Pat. Off.

Before the blast in the third section was fired, additional charges of Gelamite-D were strung and lowered between the lines of steel casings on both ditch lines. These supplementary charges, referred to as a string shot, were fired in conjunction with the charges loaded into the drill holes. The results showed no appreciable improvement and the method was not used again in section blasting.

At one or two locations along the 30-in. ditch line, the rock in the channel bed showed indications of having an underlayer of a chert formation. At these locations, some of the drill holes could not be cleaned out satisfactorily and blasts left a few high spots in the ditch. These were brought down to grade by firing string shots.

When large boulders were encountered in the excavation of the rock broken after a section had been blasted, they were reduced to easy-handling size by dobie shooting. Dynamite charges primed with Primacord were lowered onto the boulders by a clamshell unit and blasts were fired from the barge.

In the south bank of the river, operations required the blasting of 91 well-drill holes loaded with 5 in. by 25-lb. cartridges of Gelamite-D. Also, six individual blasts of 3 to 8-ft.-deep jack-hammer holes, loaded with Hercules* 40% Gelatin Extra dynamite, were fired. These latter blasts consisted of 130 to 180 holes per blast. Consistently satisfactory results were obtained.

The explosives requirements on this project were 339,925 lbs. of dynamite, and 127,000 ft. of Primacord. As previously indicated, approximately 40,000 ft. of 6-in. steel casing was used to line the well-drill holes in the river sections. Including excavating, re-handling of dobies and cave-ins, backfilling, and disposing of excess, a total

A 4,000-FT. RAILROAD: The contractor had to build a railroad on shore, which extended from the north bank of the river for 4,000 ft. Its 30-lb. rails were lined up with the ditch lines in the river.

MAIN LINE PIPE: A close-up of the 30-in. pipe with a 3-in. coating of Wate-Cote, for use in the main line crossing. Sections of the pipe were welded together into a single unit 4,000 ft. long.

of 46,702 cu. yds. of material was handled in constructing the ditches across the river. In the south bank area, 75,057 cu. yds. of rock and earth were disposed of in excavating, backfilling, and cleaning-up activities. On the north side of the main channel, a total of 177,577 cu. yds. of material was handled.

A 4,000-ft. railroad with 30-lb. rails was constructed on shore, extending from the north bank of the river in line with the ditches. The cuts and fills, excavation, backfilling, and cleanup work on this part of the project represented 14,728 cu. yds. of variable material handled.

All of the pipe was brought to the job site in automobile trucks and strung alongside of the railroad. Both the 30-in. and the 24-in. pipe had a 3-in. coating of Wate-Cote. Their weights, including the coating, were 456.73 lbs. per ft. for the 30 in. and 341.27 lbs. for the 24 in. After the railroad construction was completed, the sections of pipe were welded together into a single unit 4,000 ft. long and placed on the railroad track on skids. A set of trucks was placed under each section of pipe. The bed of the railroad was graded on a gradual slope toward the river. Twenty-five pontoons, each 14 by 19 ft., were constructed to float the pipe across the river. Each pontoon was equipped with a wench and a steel cable.

After dredging operations had completed the excavation of the two ditch lines in the river, professional divers walked the length of each ditch and recorded measurements. Their findings showed the ditches to be 8 to 12 ft. deep, 7 to 8 ft. wide at the bottom, and 20 to 30 ft. wide at the top. These results adequately met the contract specifications.

After x-ray examinations and pressure tests showed that the pipe was ready for use, the skids were removed and the 30-in. pipe was let down onto the trucks on the railroad track. Side booms and dozers were tied to the line of pipe with steel cables. This was done to provide a braking action, to control the movement of the pipe on the trucks. The weight of the pipe and the slope of the railroad tracks toward the river caused the pipe to move freely on the track.

As the pipe was eased into the river, pontoons were placed over it at various intervals and the steel cables from the wenches were tied to the pipe. As it went out into the water, the pipe was lowered by the wenches into the ditch line. This procedure was continued until the 4,000 ft. of 30-in. and 24-in. pipe were placed in the two ditch lines across the river. Further tests showed that the details of this phase of the job had been completed according to plan.

During the placing of the pipe in the river, all gates at Pickwick Dam downstream and Wilson Dam upstream were closed. As a result, there was no current to contend with in the main channel.

After the pipe was in place in the two ditch lines, draglines and clamshell buckets were put to work to place backfill into the ditches. When this was done, the main channel was checked for high spots. For this operation a 16 in. by 16 in. by 50-ft. spud bar was employed as a drag. It was anchored to the barge with steel cables and lowered near the bottom of the river bed. After it was dragged up and down the river and across the working area in the channel, everything was found to be in order and tie-ins were completed on the 30-in. line. Gas was flowing through it while the final details of work on the 24-in. line were being completed.

The supervisory personnel for the prime contractor, Brown & Root, Inc., included F. L. Terry, project manager; James Ford, project engineer; Reed Broadway, division superintendent; Loyd Harleston, pipe-line superintendent; and Charles Boatman, chief inspector, river crossing.

For the subcontractor, Oklahoma Contracting Company, Paul R. Halbert, vice president, was in charge of all operating activities for his organization. He was assisted by Aldress Kilgore and H. A. Wylie, superintendents, and H. A. B. Prindle, engineer on the project.

The amount of work involved in laying these two pipe lines across the Tennessee River was tremendous. Construction progress had to be interrupted repeatedly during the winter months because of unusually severe weather conditions. At times, the water in the river would rise from 3 to 5 ft. overnight, accompanied by a 4 to 5-mile current. The successful completion of this river-crossing job bears eloquent testimony to the resourcefulness and the know-how of the management personnel and the operating crews of Oklahoma Contracting Company of Dallas, Texas.

Miners and Quarrymen Honored at SAFETY AWARD CEREMONIES

Sentinels of Safety trophies, flags, and Certificates of Achievement in Safety are presented to employes of four mines and one quarry

The Bronze Trophy

It has long been a custom for officials of companies whose mines and quarries make the best safety records in the annual National Safety Competition to honor the employes of their winning properties at appropriate ceremonies. On these occasions, the programs are featured by formal presentations of bronze Sentinels of Safety trophies, Sentinels of Safety flags, and individual Certificates of Achievement in Safety for the employes in the respective organizations.

A review of the ceremonies at Rock Springs, Wyoming, October 26, 1952, when Union Pacific Coal Company's Reliance miners received the bituminous-coal mine trophy, was published in our November-December, 1952, issue. A summary of the proceedings for the other five winners is presented in the article which follows.

Anthracite-Mine Winner

On July 19, 1952, officials of Ploskonka Coal Company were hosts to 75 employes and guests at a dinner-ceremony in Hotel Wilson, Peckville, Pennsylvania, to celebrate the victory of their No. 5 Hill mine in the anthracite underground mine group in the 1951 National Safety Competition. The miners' winning record was 73,777 man-hours of work in the mine with only one accident that resulted in a time loss of one day.

In presenting the Sentinels of Safety trophy and flag to the No. 5 Hill miners, Joseph I. Horty, managing editor of THE EXPLOSIVES ENGINEER, commented on the improvement in the safety records of the mine during the recent four-year period, 1948 through 1951. "You reported seven disabling injuries in 1948 which resulted in a time loss of 222 man-days," said Mr. Horty. "In 1951, you had one disabling injury for the loss of one day's work. It is obvious that the improvement in your records came about through the cooperation of everyone in the organization in carrying through a well-planned program of safety. However, the major credit for your winning the Sentinels of Safety trophy is due to you men who worked in the mine."

In accepting the trophy and flag, Louis G. Ploskonka, owner of the coal company, said that "all of us will continue to do everything we know how to keep our mine a better, safer place in which to work."

Certificates of Achievement in Safety were presented to each employe of the No. 5 Hill mine by Seth T. Reese, chief, Accident Analysis Branch, U. S. Bureau of Mines, Washington, D. C. "Your excellent record," Mr. Reese remarked, "is proof that any coal mine, large or small, can be worked safely if the management personnel and the miners have the desire to practice safety." James F. Munley, state mine inspector, accepted the certificates for distribution to each man in the group.

Upon being introduced by the master of ceremonies, John A. Finan, outside foreman at Gravity Slope, brief congratulatory remarks were made by Edward Ford, foreman, No. 5 Hill mine; Henry Curtis of the mine's safety committee; A. J. Lippi, president, and Charles Kuchinski, safety director, United Mine Workers of America, District No. 1; E. H. McCleary, chief, and J. V. Mather, representative, U. S. Bureau of Mines, Wilkes-Barre district; and Lee Carson, Federal mine inspector in the district.

Nonmetallic-Mine Winner

Employes of International Salt Company's Retsof mine, Retsof, New York, were guests of honor at a dinner-ceremony in Big Tree Inn, Geneseo, New York, October 9, 1952, in celebration of their victory in the nonmetallic underground mine group of the 1951 competition. The winning record of the Retsof miners was 561,198 man-hours of work without a lost-time injury.

T. Forster Courthope, general manager of the company's properties at Retsof, and Detroit, Michigan, was master of ceremonies. In congratulating the Retsof employes for their perfect safety record in 1951, he said: "I join with my associates in rejoicing at the return of the Sentinels of Safety trophy to Retsof mine. We were honored by the award of this famous bronze statuette for victories in the 1929, 1931, 1932, and 1933 competitions. We welcome its return to us as a reward for the magnificent safety record made by you men in 1951. We hope to merit its return to us many more times in future years."

At the conclusion of his remarks, Mr. Courthope introduced Joseph I. Horty, managing editor of THE EXPLOSIVES ENGINEER, who made the awards of the trophy and flag to the winners. In accepting the awards, Stanley Martin, Retsof's mine and plant manager, said that one of the greatest assets any company can possess is the confidence of the people in its employ. "Our men have that feeling of confidence in our company 100 per cent. We're going to keep it that way and, in the doing, we'll win more Sentinels of Safety trophies."

The program was concluded with brief remarks of congratulations and

LEFT TO RIGHT: Seth T. Reese, chief, Accident Analysis Branch, U. S. Bureau of Mines; Stanley Martin, plant manager, Retsof mine; Edward L. Fuller, president, International Salt Company; T. Forster Courthope, general manager, Retsof mine; Joseph I. Horty, managing editor, The Explosives Engineer; John L. Ryon, vice president, International Salt Company; James A. Cooney, office manager, Retsof mine.

RETSOF MINERS: A close-up of some of the Retsof mine employes of International Salt Company at the dinner-ceremony in Big Tree Inn, Geneseo, New York, October 9, 1952.

"WE'RE PROUD OF YOU": Following the award ceremonies, Oliver's president, R. T. Elstad, at left, extends congratulations from everyone in the organization to the Mountain Iron miners, through their representative, George Woolcock. Mr. Woolcock is a locomotive engineer in the mine and a member of the employes' safety committee.

LEFT TO RIGHT: I. H. Rubow, superintendent, Mountain Iron mine; P. T. Allsman, regional director, and J. A. Johnson, supervising engineer, U. S. Bureau of Mines; I. O. N. Swanson, general superintendent of Oliver's eastern district.

AN ATTENTIVE AUDIENCE: During the award ceremonies at Oliver's Mountain Iron property in Minnesota, the miners paid close attention to the remarks of guest speakers and company officials.

SOUDAN MINERS: R. F. Wilson, Oliver's supervisor of safety, expresses sincere appreciation for the cooperation of the Soudan mine employes in carrying out the company's program for safety on the job.

sincere hopes for continued success by Edward L. Fuller, president, and John L. Ryon, vice president, International Salt Company.

Open-Pit-Mine Winner and Metal-Mine Winner

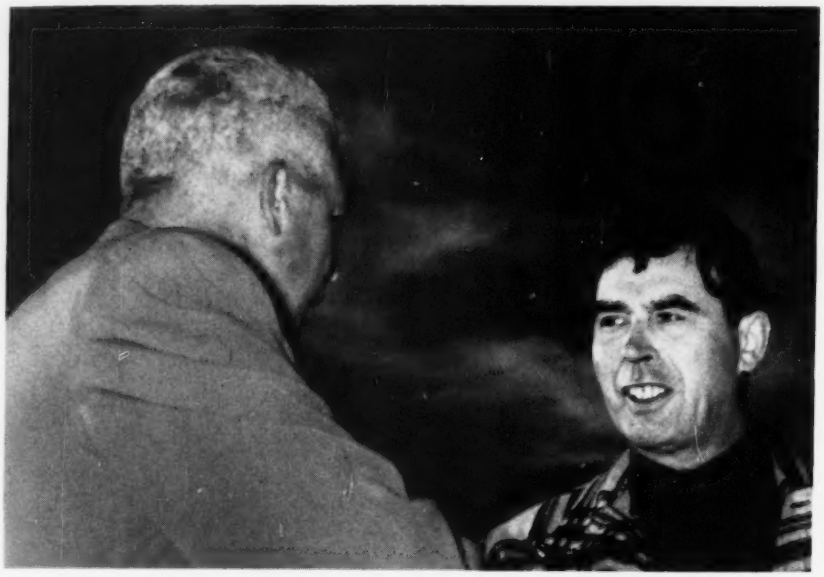
For the second time in four years two of United States Steel's Oliver Iron Mining Division mines in Minnesota were the winners in the National Safety Competition in their respective classifications. Its Mountain Iron mine won first place in the open-pit-mine group in the 1951 contest with an operating total of 789,644 man-hours without a disabling injury. Its Soudan mine came in first in the underground metal-mine group, with a safety record of 501,530 man-hours of work in 1951 without a lost-time accident. Sentinels of Safety trophies and flags, and engraved certificates for each employe at the winning properties were awarded at ceremonies held at the mines.

Oliver's supervisor of safety, R. F. Wilson, opened the program of events at Mountain Iron mine. This was followed by the award of the trophy by P. T. Allsman, regional director of the U. S. Bureau of Mines, to J. E. Machamer, vice president of operations for Oliver. Mr. Machamer called I. H. Rubow, superintendent of the mine, to the speakers' stand to accept the trophy on behalf of his Mountain Iron associates.

The green-and-white Sentinels of Safety flag was presented by J. C. Richards, technical sales representative of Hercules Powder Company, to George Woolcock, locomotive engineer at the mine. The individual certificates for each miner were awarded by J .A. Johnson, supervising engineer, U. S. Bureau of Mines, to F. D. Woleben, Oliver's district safety supervisor, for distribution to the Mountain Iron mine employes.

At 3 p.m. Friday, October 10, 1952, out-of-door ceremonies were held at Oliver's Soudan mine at which 250 hard-rock underground miners participated. The company's safety supervisor, R. F. Wilson, again acted in the capacity of master of ceremonies. P. T. Allsman, regional director for the U. S. Bureau of Mines, awarded the coveted bronze trophy to Oliver's vice president, J. E. Machamer, who, in turn, presented it to E. M. Holmes, superintendent of Soudan mine.

AT SOUDAN MINE: J. E. Machamer, at right, vice president, Oliver Iron Mining Division of United States Steel Company, presents the Sentinels of Safety trophy to E. M. Holmes, superintendent of Soudan mine, winner in the underground metal-mine group.



"CONGRATULATIONS": John H. Wilson, at left, assistant manager of Duluth district, Hercules Powder Company, representing The Explosives Engineer, awards the Sentinels of Safety flag to George Nemanich, mine captain, representing the Soudan miners.

The Sentinels of Safety flag was presented to the winning miners by J. H. Wilson, assistant manager of Hercules Powder Company's Duluth district. George Nemanich, mine captain at Soudan, accepted the flag on behalf of his fellow miners.

Engraved Certificates of Achievement in Safety for each man in the mine organization were awarded by J. A. Johnson, supervising engineer of the U. S. Bureau of Mines, to F. D. Woleben, Oliver's district safety supervisor, for later presentation to the Soudan employes.

The ceremonies were concluded with an address by R. T. Elstad, Oliver's president. "The safety achievements recorded at our Mountain Iron and Soudan mines," he said, "bring great honor to the Oliver organization. Your company officials, through me, extend sincere congratulations to each man who played a part in winning

THE TROPHY: Edward Leonard, at left, safety director of Inland Steel Company's quarries and iron-ore mines, accepts the award of the Sentinels of Safety trophy from John A. Johnson, district supervising engineer of the U. S. Bureau of Mines.

THE FLAG: John W. Adams, left, sales-service representative of Hercules Powder Company, awards the Sentinels of Safety flag to John Moffat, superintendent of Port Inland quarry.

THE CERTIFICATES: John A. Johnson, left, U. S. Bureau of Mines, awards Certificates of Achievement in Safety to Richard Freeland, labor union president at Port Inland.

these outstanding awards. Credit for 'no-time-lost' operating records must be shared by each man in the respective mines. It is obvious that only through the combined efforts of everyone can such results be realized."

The Quarry Winner

In ceremonies held at the quarry property in Gulliver, Michigan, October 15, 1952, the Sentinels of Safety trophy and flag, and individual Certificates of Achievement in Safety were presented to the employes of the Port Inland quarry of Inland Lime & Stone Company. A. W. Heitman, general superintendent, was in charge of the sequence of events on the program.

John A. Johnson, district supervising engineer for the U. S. Bureau of Mines, made the official award of the Sentinels of Safety trophy to the quarry workmen. In commenting on the perfect safety record at Port Inland quarry in 1951—808,389 man-hours of work without a disabling injury—Mr. Johnson said: "This quarry has participated in the National Safety Competition for the past 19 years. During that time it has been operated for 10,848,079 man-hours with consistently low accident-frequency and severity rates. It was the winner of the Sentinels of Safety trophy in three of those years—1938, 1939, and 1951—and was awarded honorable mention in 1933 and 1934. Everyone associated with you and your quarry, directly and indirectly, is proud of your consistently splendid performances in carrying out your safety programs. Keep up the good work."

Edward Leonard, safety director of Inland's quarries and iron-ore mines, accepted the trophy on behalf of the Port Inland employes.

John W. Adams, sales-service representative of Hercules Powder Company, representing THE EXPLOSIVES ENGINEER, presented the Sentinels of Safety flag to John Moffat, superintendent of the quarry, representing the employes. Following brief comments by Mr. Adams and Mr. Moffat, the green-and-white flag was hoisted up the plant flag pole under Old Glory.

The ceremonies were concluded by brief remarks from A. J. Cayia, president of Inland Lime & Stone Company and manager of Inland Steel Company's ore mines and quarries.

BLASTING A CHANNEL THROUGH NEW JERSEY MUD FLATS

THE NEW CHANNEL: A close-up of the new channel with the tide almost out. Everyone associated with the project was impressed with the speed and economy with which this problem was solved by the use of explosives.

George M. Brewster & Son opens a new route for tidal water and mosquito-control drainage near Wildwood with 800 pounds of 60% nitroglycerin dynamite

PAUL W. MILLER*

In building a new four-lane access boulevard to Wildwood for the New Jersey State Highway Department recently, the contracting firm of George M. Brewster & Son, Bogota, New Jersey, placed approximately 600,000 cu. yds. of earth fill along the north side of the right-of-way. The filling operations closed the end of a creek near the site of an old bridge which had been removed. The closing of the creek necessitated the construction of a new channel route for the flow of tidal water and to provide drainage for mosquito control.

The new channel had to be opened for a distance of 190 ft. through mud flats in which the soil was a black, mucky silt covered with seaweed. The employment of heavy mechanical equipment in such soft, boggy material involved heavy expenditures of operating time and expense plus the possibility of loss of equipment. The Brewster company decided to open the new waterway by blasting a channel with dynamite.

An experimental blast covering 30 ft. in length was fired. The results were successful and the Brewster company's crews went to work to complete the project on that basis.

Using a bar 1½ in. in diameter, workmen put down ten rows of holes 2 ft. apart, 4½ to 5 ft. deep, spaced on 2-ft. centers. Each hole was loaded with six cartridges of Hercules† 60% Nitroglycerin Dynamite, in 1¼ by 8-in. cartridges. The dynamite charge in the center hole in each row was primed with a No. 6 blasting cap and 3 ft. of safety fuse. Traffic was halted on the adjoining roadway at an approximate distance of half a mile from both sides of the blast area. The "all clear" signal was given, the fuse was lighted, and, after a short interval, the blasting caps exploded and detonated the dynamite

*Hercules Powder Company
500 Fifth Ave., New York 36, N. Y.

†Reg. U. S. Pat. Off.

ON THE MUD FLATS: J. H. Kegerreis, superintendent for George M. Brewster & Son, at right, and the author, Paul W. Miller, discuss plans for completing the channel by blasting in the mucky silt covered with seaweed.

charges in the center holes. The wet, mucky soil acted as a conductor of the wave of detonation, and the charges in the adjoining holes were detonated at, apparently, the same time. The blasts resulted in a clean, open channel 190 ft. long, with a minimum depth overall of 4½ ft. and a width at the bottom that averaged 20 ft.

Everyone associated with the project was impressed with the speed and economy with which this troublesome problem had been solved by the skillful use of explosives and the propagation method of blasting.

The supervisory personnel for the contractor, George M. Brewster & Son, included A. J. Seaman, project manager; S. W. Engleman, assistant project manager and resident engineer; W. O'Connor, project superintendent; J. H. Kegerreis, superintendent; and R. Clark, engineer on the project.

PREPARING TO BLAST: Using a 1½-in.-diameter bar, workmen put down ten rows of holes in the mucky soil and loaded six cartridges of dynamite into each hole.

AFTER BLASTING: The firing of 800 lbs. of 60% nitroglycerin dynamite in ten rows of holes opened a 190-ft.-long channel through the muck. The depth of the channel is 4½ to 5 ft. and the bottom width averages 20 ft.

MOB RULE: In the accompanying article, Dr. Rutledge dramatically focuses attention upon the many differences between labor relations today and those of a half century or more ago. Here, unimpressed miners of the nineties are literally and figuratively driving the "boss" off the job.

Striking Off the Boss

In the early days of coal mining, superintendents and foremen had to be rugged individuals

J. J. RUTLEDGE*

MANY YEARS AGO, when the mining of coal for commercial purposes in the United States was begun, only a few mines were opened for operation and the tonnage production of each mine was small. Published literature on the technical phases of coal mining was practically nonexistent—only one magazine in this country included articles on how a coal mine should be operated, and such material was presented infrequently. The supply of men with experience in underground mining was limited. The majority of experienced miners available were pick-and-shovel workers who had come to the United States from England, Scotland, and Wales. Naturally, they were welcomed and given jobs by the operators, not only because they were skilled craftsmen in their trade, but also because they were familiar with the English language.

*Deceased

These immigrant miners had left their homes in Britain to come over here because the United States was a free country and they would not be subjected to the stern discipline of British miners and strict adherence to British mining laws. They soon realized that their services were in demand and, in the vernacular, they occupied the driver's seat around the mines. Imbued with the British miners' prejudices, they expressed themselves freely and vociferously on any and all subjects whenever and wherever they felt the urge. The next step was to take the law into their own hands if they disliked people and things with which they were associated. The instigators of movements to take direct action were usually the older miners, some of whom were physically incapable of doing an honest day's work. If a foreman incurred their disfavor, they would incite the younger miners to join with them and to force him to leave town and never return. This highhanded custom became known as "striking off the boss."

A Case in Point

The writer recalls very clearly one such incident that occurred in one of our middle-western states. The merchants in a small community organized a company to open and operate a coal mine on the outskirts of the town and sold stock locally to finance the venture. A nearby farmer was elected president of the company and he employed a practical miner from a distant locality to supervise the sinking of a shaft at the mine site. After the shaft had been drilled, blasted, and excavated to the desired depth, the supervisor recommended a young and vigorous miner from his home town to take over the duties of foreman of the new coal mine. The young man was hired and operations were begun.

A few weeks later, differences arose between the miners and the foreman concerning hours of work, the rate of pay for "dead work," and other details connected with the underground mining of coal. The older miners, particularly those who were physically unfit, were the prime movers in the arguments and discussions. The young foreman tried his best to overcome the opposition of the men and, at the same time, to enforce some semblance of discipline among them. But the miners persisted in their opposition.

One Saturday afternoon, after work underground had been discontinued for the week end, a group of miners came to the mine office and ordered the foreman to come outside and accom-

pany them to the railroad station. The foreman did as he was ordered and the walk to the station began. En route to their destination, the grim-faced men surrounded the terrified foreman and forced him to pass through the center of the town. Townspeople stopped to watch the strange parade, among them the president of the coal company. He realized, as did the foreman, that it was futile to offer resistance to the will of the angry mob of miners. The miners and their "prisoner" proceeded to the railroad station where the foreman boarded a train and left the community with orders from the miners never to return.

The company president sent a telegram to his former shaft supervisor to come to town at once to help in a serious emergency. After the supervisor arrived and was told about the recent happenings, he remarked that had he been the foreman he would have had to resist, even if some of the miners were killed in the fracas. The president asked the supervisor to take over the running of the mine until a new and different type of foreman could be employed. The supervisor agreed and devoted much of the time during the next ten days to mixing with the miners, especially the older miners who were the leaders in disregarding work orders and regulations. He was an even-tempered, tactful man with an ingratiating personality. Gradually he impressed upon the miners that they had been guilty of a foolish mistake. "If you will stop and think," he said, "that your jobs in this mine depend on whether the owners feel that it can be operated at a profit, you will agree to do what is right and get out coal that can be sold at a profit. If you don't follow orders and the mine is operated at a loss, the local stockholders will shut it down and you men will be out of work and will suffer the biggest loss."

After a week or so of mixing with and talking with the miners, the shaft supervisor persuaded the president to call for a joint meeting of the miners and the stockholders and to state emphatically that the mine was going to be shut down unless the miners agreed to cooperate with a new superintendent who would arrive soon. The meeting was held and the miners left the gathering with no indication of what their future procedure would be.

MIDNIGHT CALLERS: Sixty years ago, a strong, fearless "boss" sometimes brandished a rifle to back up authority, Dr. Rutledge points out. Fortunately, much progress has been made since those early years.

Superintendent James O'Toole

Among several prospective superintendents considered by the company president, a man named James O'Toole appeared to offer the most promise. He had been described as a husky, courageous six-footer who knew how coal should be mined and how to handle men. He was sent for and, in due time, the president called him to his office for an interview. The man entered the office dressed in overalls and carrying a flame safety lamp in his hand. "My name is James O'Toole," he said, "and I'm an Irishman and proud of it. I've heard of some of the troubles you've been havin' and I'd like to try my hand at straightenin' out some of them." He was promptly hired and taken to the mine for an inspection tour of his new surroundings.

At the end of the work shift in the mine, O'Toole returned to the mine office and went to a room in the rear to change into street clothes. Returning to the front office, he found the president seated in a chair. The two men engaged in a thorough discussion about the general conditions prevailing in the underground workings.

After the president had left for his home, O'Toole ate some food he had brought in his valise and, in a short time, went to bed in a room at the rear of the office building. At midnight he was awakened by a loud pounding on the front door of the office. Before going to the door, he opened a closet in the bedroom and discovered a rifle which, he learned later, had been placed there by the president. A quick inspection revealed that the rifle was in excellent condition and fully loaded. With the rifle in his hand, he opened the door and saw a group of about 30 men facing him. He asked them what was going on and their leader replied, "Super, we're gonna run you out of town. We run this mine and we won't stand for any interference from anyone, including you." O'Toole raised the rifle to his shoulder and pointed it straight at the leader. "Boys," he said, "you're not gonna run me out of town. Come and take me if you can. Before you make a move, remember that I'm pointing a loaded rifle at you and it has a fine range. I'll surely kill a dozen of you before you can pass this door." As his voice died away, the group began to scatter and some in the rear turned and ran away. The leader wavered and then turned and fled. As they ran, some of the men who knew firearms called out that the rifle aimed at them could kill at a distance of half a mile. The terrified miners kept running until they reached their homes and disappeared from sight.

By the time the whistle blew for work the next morning, everyone in town, particularly every worker at the mine property, had heard of the events of the night before. The miners went down the shaft to their working places and operations began on time and proceeded without delays or interruptions through the shift. The new superintendent was the boss, and none of the miners questioned his orders and directives. It is a pleasure to record that O'Toole remained the boss of operations at the property until the mine was worked out.

CONSTRUCTION UNDER WAY: Work on the project began with the excavation of the approach to the east tunnel portal. The steel framework in place is the foundation structure of the east ventilating building.

San Francisco's Broadway Tunnel Under Russian Hill

Morrison-Knudsen's introduction of a unique breastboard jumbo made possible full-bore operations and a tunnel advance of 15 ft. a day through badly fractured ground

ROBERT LEE BEHME*

SAN FRANCISCO's famous hills became a problem to the City Fathers as early as 1863, when the need for shorter routes to the rural districts surrounding the town became apparent. Following considerable investigation and discussion, the Board of Supervisors issued a permit to Abner Doble to construct a tunnel under a hill in the heart of San Francisco's residential district, referred to locally as Russian Hill. The tunnel was to tie together the edges of San Francisco with a rapid transportation system. In the flurry of history which followed, the tunnel failed to become a reality. Doble passed away and with him went his underground transportation dream.

In time, tunnels arrived on the San Francisco landscape. By 1912, a 900-ft. tunnel had been completed to link Stockton Street and the north. Other tunnels followed and, in 1940, activities were climaxed by the construction of a State-sponsored super highway tunnel linking city thoroughfares with the Golden Gate Bridge.

A population shift during World War II focused attention on the need for a direct route between San Francisco's business district and the northwest Marina area. City authorities reviewed the situation, and Doble's dream was resurrected. A twin-bore tunnel under Russian Hill on Broadway Street, between Powell Street on the west end and Polk Street on the east end, was scheduled as a major postwar project.

Plans Approved for Two Vehicular Tunnels

In 1947, the project was financed as part of a $22,850,000 bond issue, which voters had approved at the polls. By January, 1950, plans and drawings

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Los Angeles 46, California

were completed for the project, under the direction of Ralph G. Wadsworth, city and county engineer. The plans called for two vehicular tunnels to be bored through Russian Hill, each 1,364 ft. long, having a maximum grade of 3 per cent and dropping slightly on the western end. The total alignment, including both bores and approach cuts, would cover over 3,300 ft. To give maximum structural independence, the tunnels were to be about 35 ft. apart, except at the approaches.

Morrison-Knudsen Company of Boise, Idaho, was awarded the contract on February 8, 1950, on its bid of $5,253,552.33. Official starting time was scheduled for May 1, 1950.

To secure necessary right-of-way for the project, the City had to possess 40 parcels of land and all occupied buildings, ranging from single dwellings to 12-unit apartment houses. Some structures were moved back to clear the right-of-way while many others were moved to new locations. Many of the older buildings were completely demolished.

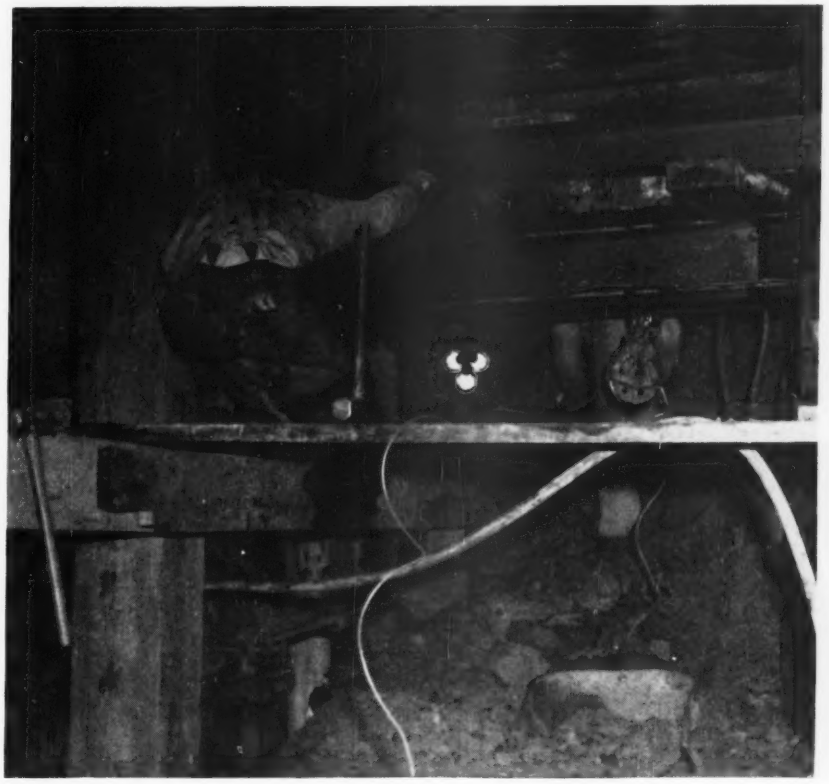
Work on the project began with the excavation of the east ventilating building and the east approach. This was accompanied by the drilling of holes for a series of soldier beams extending around the east of the tunnel portals. The holes were drilled to a depth of 65 ft., extending below the final subgrade level.

The contractor's crews found that the material encountered at the east portal location was a highly unstable fill material in what appeared to be a long-forgotten ravine. The predicted hard-rock conditions were not encountered, and Morrison-Knudsen's plans had to be changed. Behind the challenge of the change lies the story of one of the most difficult tunnel-driving projects which M-K crews have ever experienced.

A Unique Breastboard Jumbo

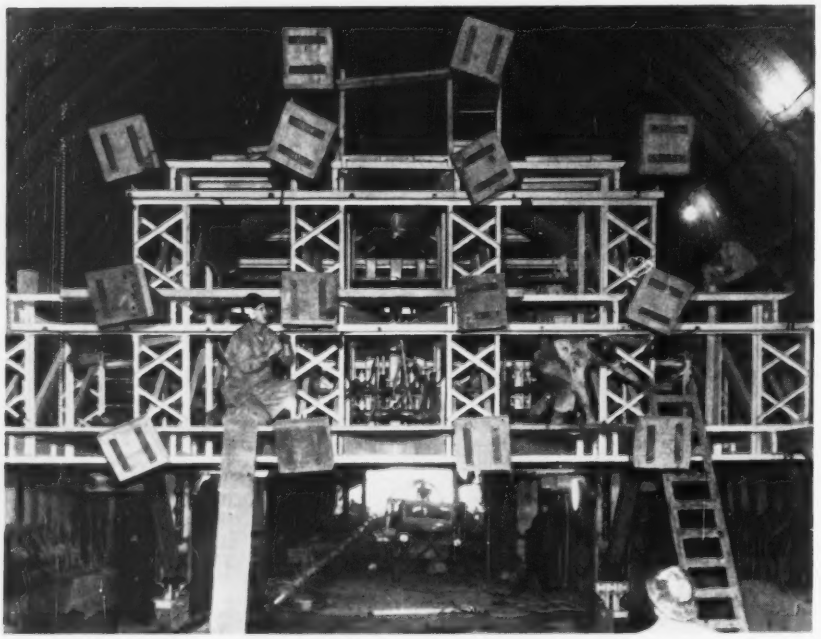
The driving of full-size 22 by 28-ft. tunnel bores was ruled out by the contractor. Other methods were examined but were discarded because of

UNDERGROUND: During the early operations underground, the unstable material in the foot block drifts had to be supported with lagging.



HAND MUCKING: Miners spaded down the muck from a working face and carried it to a Joy mucking machine for loading into mine cars.

WET GOING: During the rainy season in the winter months, mechanical mucking-out activities were somewhat complicated by the seepage of rain water.



A UNIQUE JUMBO: The introduction of this unique breastboard jumbo made possible full-bore operations and a tunnel advance of 15 ft. a day.

excessive cost and time consumption. A new technique had to be developed. Morrison-Knudsen's vice president, Lyman D. Wilbur, came up with an idea which made possible the tunnel's rapid excavation. He designed and had built a unique breastboard jumbo, which made possible full-bore operation after driving 2-ft. block drifts. Its use permitted three shifts of miners to move forward at a rate of about 15 ft. a day in a section 34 ft. wide and 24 ft. high, with a radius of 14.3 in. above the spring line.

The introduction of Wilbur's jumbo minimized the need for many tunnel drifts, and only the driving of foot-block drifts 9 ft. wide, extending to a point about 1 ft. above the spring line, was needed. This procedure permitted sufficient space to allow for the placement of wall plates and 12 by 12 timber caps in the plumb posts.

The change in tunnel-driving procedures also brought a change in the steel fabrication plans. It necessitated the removal of 6-ft. 10-in. sections from the ten WF 54 plumb posts and the welding of these to the half-arch rib sections. The foot blocks were supported on the outside of each projected tunnel area by steel plumb posts, and by timber posts on the inside. In addition, they were supported by extensive lagging and blocking throughout the length of the drifts.

As previously indicated, excavation was begun on the east portal, proceeding toward the center of the alignment. Concrete and appurtenant works followed. Near the center of the south tunnel a stub was driven from drift No. 4 over to the alignment of drift No. 3. The excavation of drift No. 3 was then begun, proceeding both east and west to meet the sections which had been driven earlier from the portal areas. It was the existence of lengths of No. 3 drift near the east portal which permitted the contractor's crews to use Wilbur's breastboard jumbo in full-face operation on the east portal in the early workings.

In discussing the jumbo and its operation with Louis L. Wheeler, Morrison-Knudsen's project manager, he remarked that "a good description of it might be given by comparing it with a shield used when mining under pressure."

From the face of the jumbo, 18 hydraulic jacks reach out like massive hands. These jacks exert a total pressure of 160 tons against the boards covering the face of the tunnel heading. At the rear of the jumbo, four jacks clamp against the side of the tunnel to hold the machine tightly against the heading. Working from the jumbo, drillers free the muck with pneumatic spades and picks. In early operations, the muck was handled by a Joy HL 20 mucking machine and loaded into mine cars. As excavation proceeded, the material was mucked from the jumbo downward for further handling by an operator employing an Eimco 104 rocker shovel.

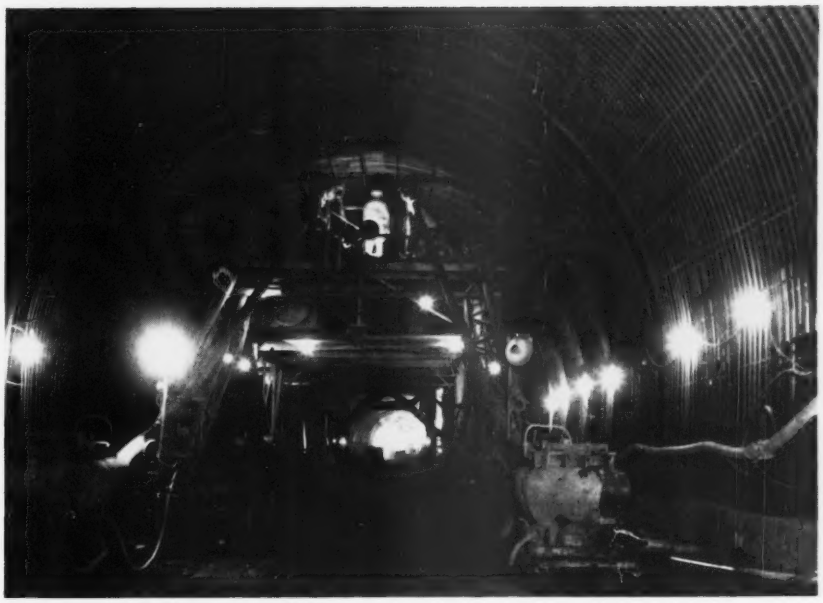
Operating Procedures

A work cycle began when the jumbo had been secured in its new position, with the breastboards compressed tightly against the excavated face. The drilling and blasting crews ascended the jumbo to drill and load a round. In Wheeler's words, "The purpose of blasting was not to move the material, but rather to shake it up so that it could be removed easily with the air spades."

The material prepared for blasting at the tunnel site comprised badly fractured rock, weathered sandstone, blue sandstone, clay, and gouges. The formation varied from hard to weak, interspersed with seams. The rock slaked badly when exposed to air. Using Copco Swedish drills with 1⅝-in. steel bits, the miners drilled a random pattern of holes from 4 to 6 ft. long. Air supply for the equipment was delivered by a battery of three XLE Ingersoll-Rand compressors. A 6-in. line was laid the entire length of the project to deliver air to the west portal.

Drill holes were located predominantly in the crown. Where necessary, some were extended to the right and left down the face, toward the wall plate line. Once holes were drilled, the jumbo's lighting system was extinguished and a portable illuminating system was used while the dynamite crews loaded the holes along the crown. The charges of dynamite varied from one-half to two cartridges a hole. The crews used Gelamite® 2 in 1⅛ by 8-in. cartridges. The average charge was 3/10 lb. of dynamite per cu. yd. of material in place. In rare cases, the loading ratio was as low as 15/100 lb. per cu. yd. The maximum used on the project never exceeded 7/10 lb. per cu. yd.

®Reg. U. S. Pat. Off.



PLACING STEEL: A view of the shooting pipe jumbo in operation, with the crew placing steel lining in the tunnel arch in preparation for concrete work.

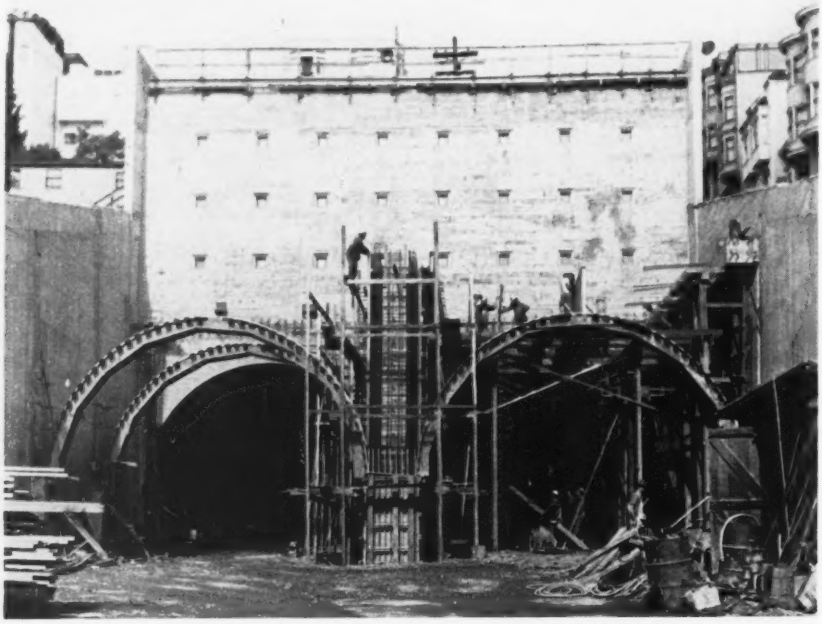
STEEL RIB STRUCTURE: A close-up of the false arch in the ventilating building, with workman completing the steel rib structure arrangement.

Short-Period Delay Electric Blasting Caps Minimize Vibration

The charges were primed with short-period delay electric blasting caps, using from 1 to 7 periods of delay. Each loaded hole was stemmed to the collar with sand, packed into cartridge containers to conform to the size of the dynamite cartridges. The use of short-period delay detonators reduced vibrations from blasts to a minimum—an important factor in view of the immediate residential surroundings.

After the material in a working face had been loosened by a blast, it was mucked out by a crew on the jumbo. When secondary blasting was necessary (an unusual requirement), the blocky material was drilled, loaded, and blasted, after which the face was prepared for the next round.

CONSTRUCTION SUPERVISORS: Morrison-Knudsen's key men on the Broadway tunnel contract were, left to right, Harry Kirmond, assistant project manager; Carl Larson, tunnel superintendent; Louis L. Wheeler, project manager.



THE VENTILATING HOUSE: The building is supported by extensive strut and diagonal arrangements. Steel supports were tested for a load greater than the ultimate total of the structure.

The consistency of the ground was such that miners could chip off large slabs with little effort. The area along the top of the face of the jumbo was worked by eight miners. Each man mucked a 4-ft.-deep excavation in the area of the breastboards. When this was completed, the hydraulic-operated breastboard for that area was placed in its new position. Following this procedure, lagging bars, collar bracings, ribs, and crown bars were placed in rapid succession. Other operations, such as the control of the jacks and the supply of material, required the employment of about 12 men. The men needed for this jumbo operation totaled about 20.

Below the jumbo, an Eimco 104 rocker shovel was kept busy mucking out the material, which had been loosened by the air spades, and loading it into trucks for transportation to the outside dump area.

In addition to making thrusts straight at the face of a cut, the rocker shovel was able to turn and attack areas to the right and left where fallen material had practically buried the foot block drifts. Approximately 80,000 cu. yds. of waste material was taken from both bores and hauled 5 miles through heavy city traffic to Islais Creek near Hunter's Point for final dumping.

While protecting the face, the jumbo overhangs its front wheel assembly along the complete length of the jack frame assembly. From the shovel operator's standpoint, the jumbo was never hard against the face of the tunnel and adequate maneuvering space was always available for the rocker shovel. The huge bore had the additional advantage of providing truck drivers with ample space to place their trucks for shovel-loading operations.

Clearing the Face

When it was time to clear the face for the operation of the rocker shovel, it was necessary to remove the timber posts on the inboard side of the foot block drifts and the caps and spilings they supported. The spiling was weakened by a line of holes drilled along the side of a 12 by 12-in. cap, using a power auger. This was done only after most of the overburden had been mucked out. The weakened spiling was removed safely with a chocker wire running to the rocker shovel. Plumb posts, drilled through as close to their base as possible, were similarly removed.

Ventilation, always a problem within the Broadway tunnel, was greatly improved by huge blowers which M-K fashioned from airplane propellers and 75-hp. electric motors. All of the Diesel units used in the tunnel were equipped with "scrubbers," a system of chemicals, water, and baffle plates within a tank, which removed the danger from the fumes of the exhaust.

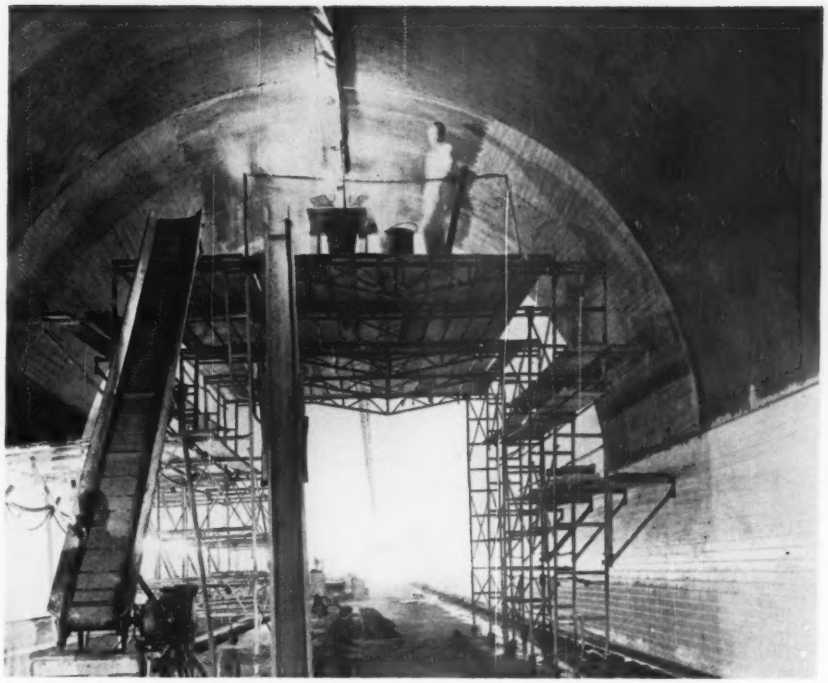
During each of the jumbo operations, its position was consolidated. When the details of mucking and supporting the face were under way, the jacks were forced against the face of the excavation. After that, attention was given to the manually operated screw jacks, turned up against the tunnel sets as a safety measure.

The hydraulic rams were moved ahead at one time, eased, then retracted and extended again to bring pressure on the tunnel sets closer to

the face. Under Wilbur's direction, the jumbo was designed to spread leverage against especially designed plates that distribute the power load along several of the ribs on the tunnel. When the rams had been properly set, the jumbo was ready to move forward into new working territory. A path was cleared along the tracks for 5 or 6 ft., and the shifter gave the order to the crew to move the jumbo. Slowly, like a lumbering elephant, the jumbo would begin to move forward; the breastboard jacks would compress. Although the movement seemed slow, it took a crew only five minutes to move the jumbo 3 to 4 ft. into a new position. Once it was set in its new position, the shifter would give the final signal to stop the jumbo.

Project Supervision

For the City of San Francisco, the overall activities on this project were supervised by Sherman Duckel, director of public works; Ralph G. Wadsworth, city and county engineer; George Partridge, resident engineer; and Tom Mullaney, chief tunnel inspector. For the contractor, Morrison-Knudsen Company, Inc., the details of construction were directed by Louis L. Wheeler, project manager; Harry Kirmond, assistant project manager; John Erdle, project engineer; Gerry Eide, office engineer; Dan Butler, office manager; Carl Larson, tunnel superintendent; and Jim Miller, master mechanic on the Broadway project.



YELLOW TILE FINISH: In lining the tunnels with yellow tile, workmen first apply base mastic then set, surface, and apply the tile. The finished walls and fluorescent lighting effect a beautiful tunnel for the motoring public.

As thousands of San Francisco's motorists hurry through the beautiful tunnel with its yellow tile walls and brilliant fluorescent lighting, they would do well to pause momentarily to give thanks that Abner Doble's dream has at last become a reality.

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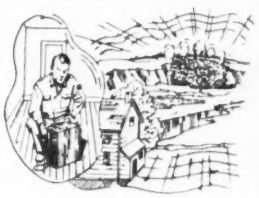

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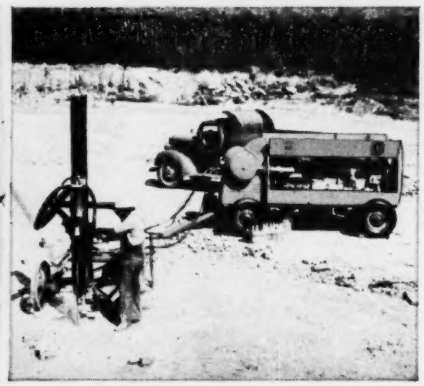
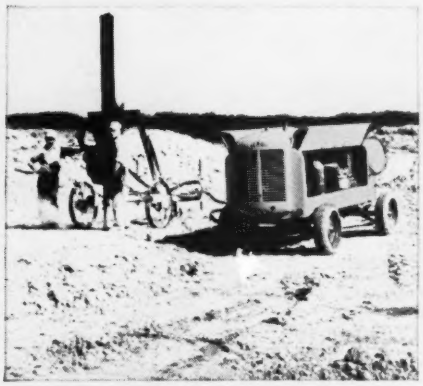


New 250 cfm — Diesel-powered. Operates two lightweight wagon drills, like the Le Roi-CLEVELAND DR-34, or one heavy wagon drill, like the Le Roi-CLEVELAND DR-30. Price is same as former 210 diesel.



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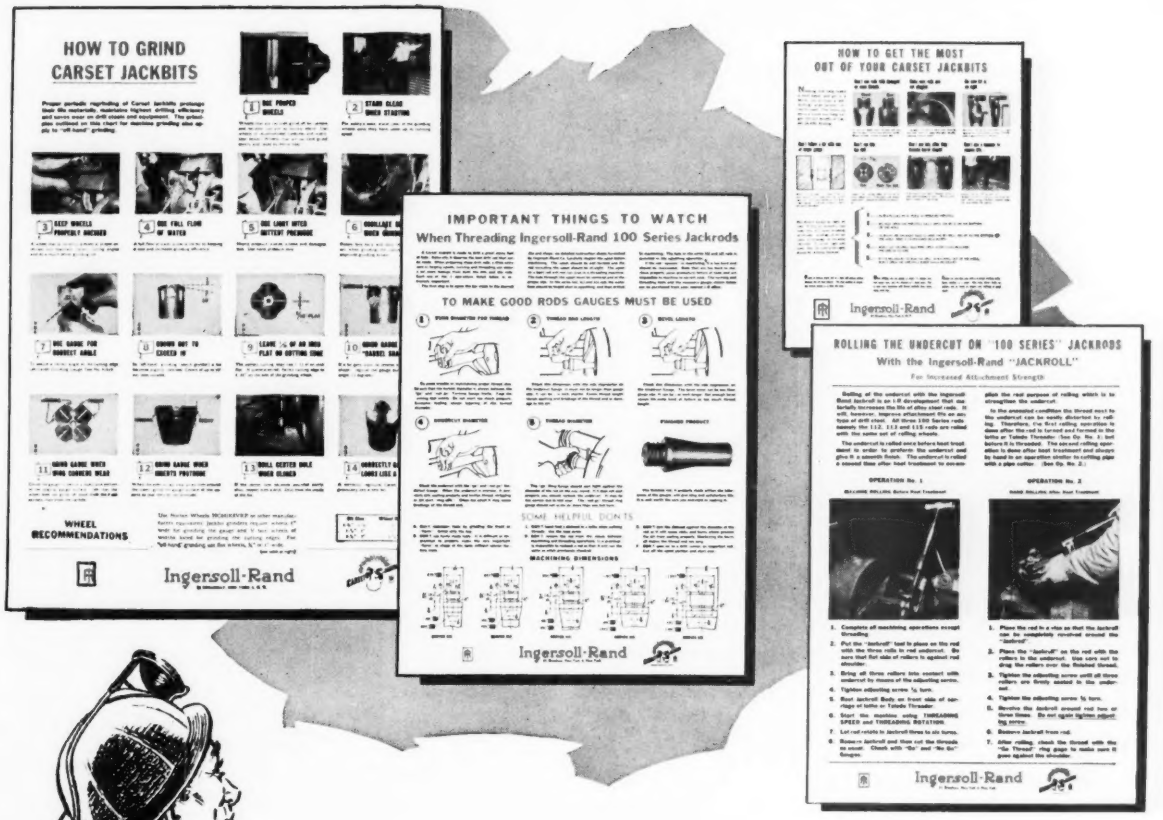

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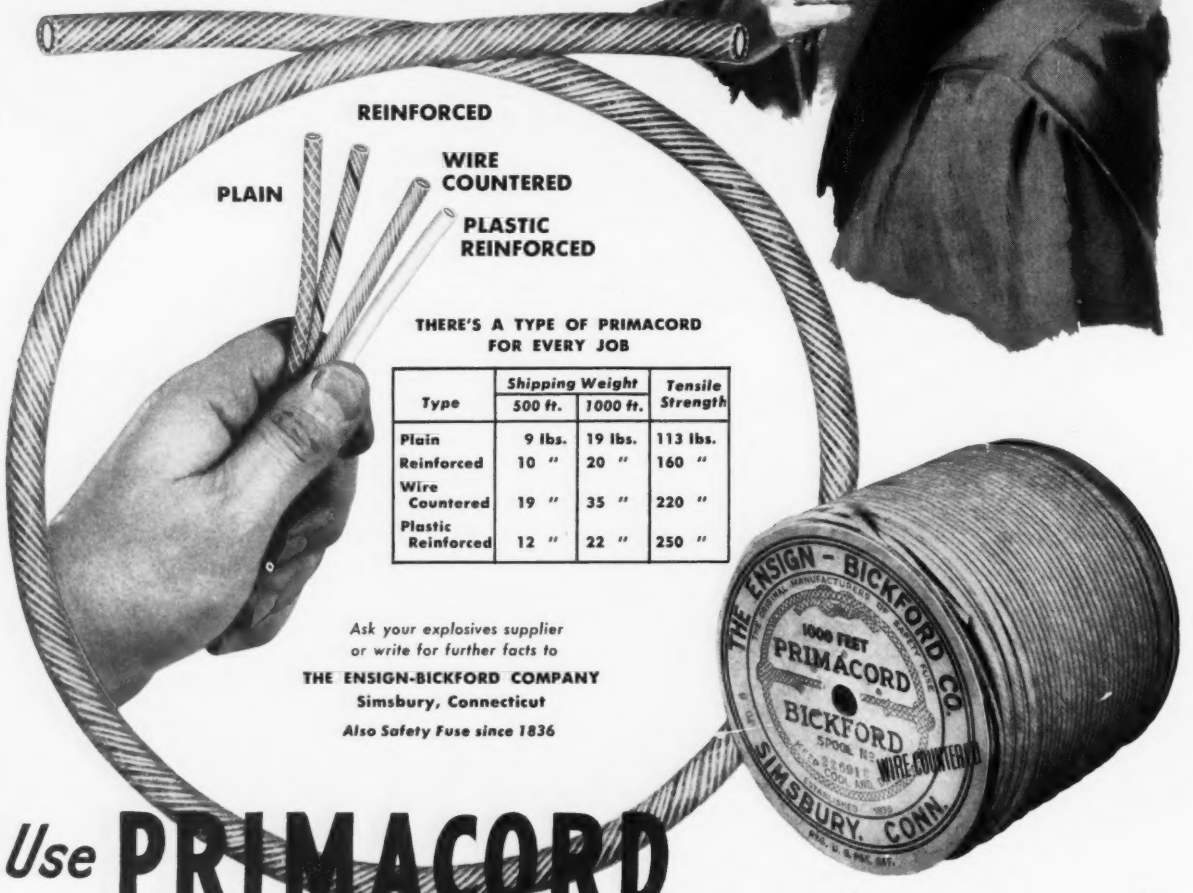

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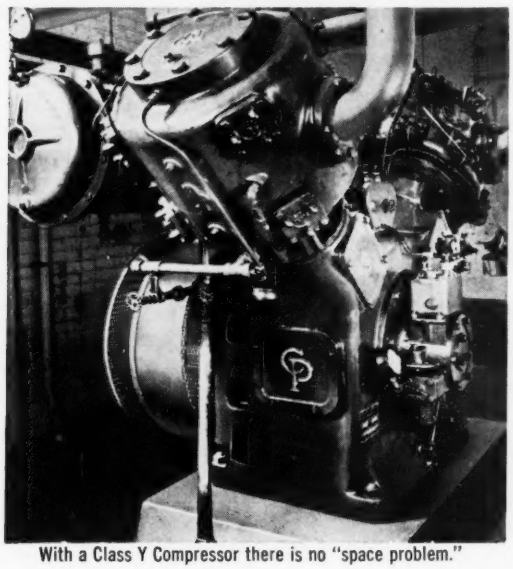

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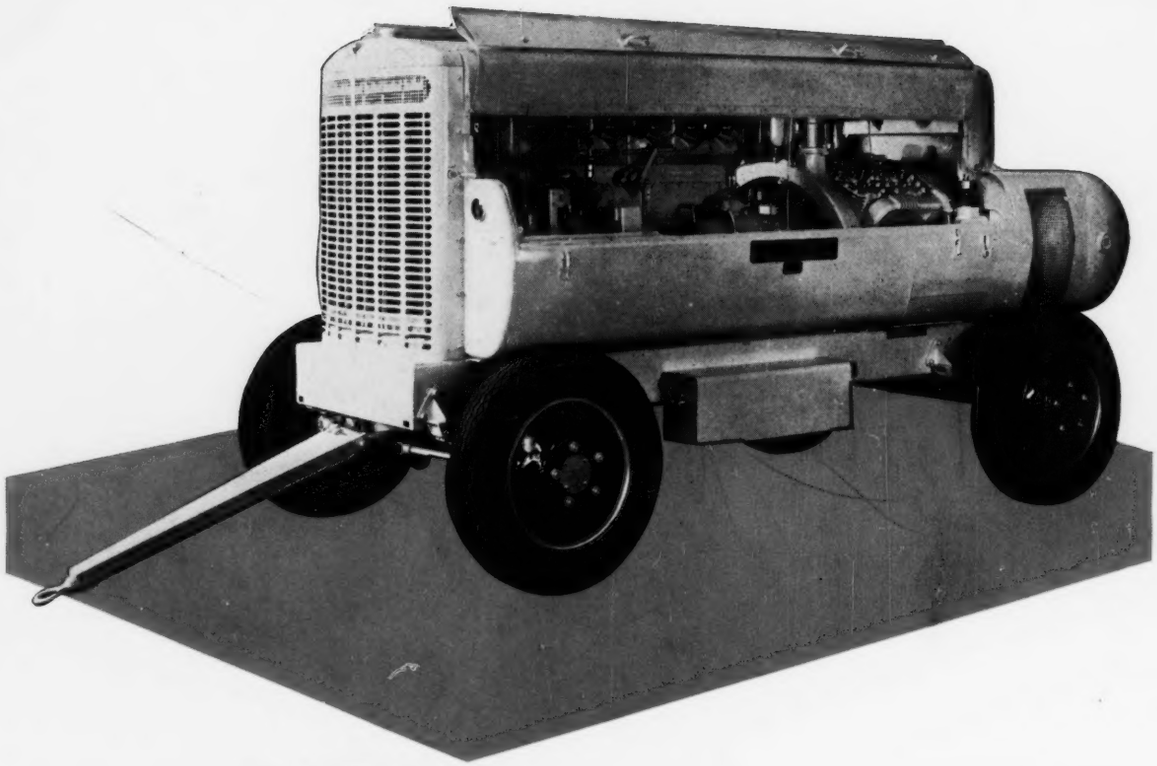

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